

INDUSTRIAL

SOURCES

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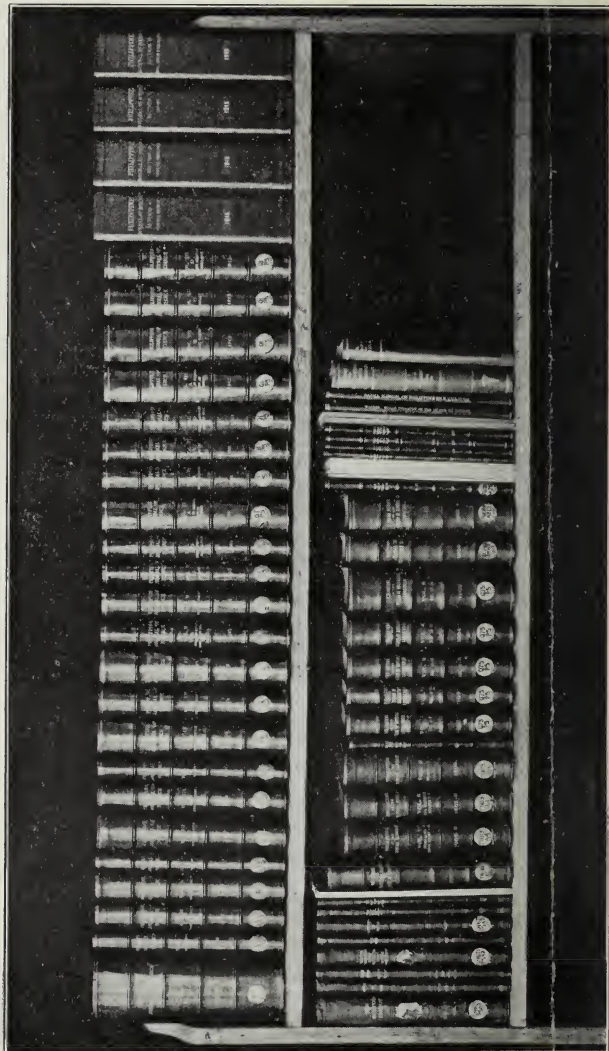
PHILIPPINE

ISLANDS



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THE GOVERNMENT OF THE PHILIPPINE ISLANDS
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ALVIN J. COX, *Director of Bureau*

INDUSTRIAL RESOURCES OF THE PHILIPPINE ISLANDS

The resources of a country form the basis of its prosperity, but the degree of prosperity depends upon the manner and extent to which the resources are utilized. Economic processes, modern machinery, and scientific industrial methods must be used to develop them to their fullest extent. The establishment and development of successful new, as well as the improvement and perfection of old, industries must be founded on scientific knowledge, so there should always be close coöperation between scientific workers and the actual producers.

Many of the valuable resources of the Philippine Islands are insufficiently, or not at all, developed. The Bureau of Science has been studying the problems connected with some of these, and the results of this work although available are not generally appreciated. They cannot attain their full value until the principles discovered are industrially and commercially utilized. In some cases, however, commerce has been quick to realize the importance of this scientific investigation, and a number of industries are being established as a result of it. The aim of this pamphlet is to indicate the results of this work, hoping thereby to arouse further interest in the Philippine resources and to stimulate the development of both old and new industries. Detailed information concerning many of the following subjects which are discussed can be obtained from the Bureau of Science.

CONTENTS

CHEMICAL TECHNOLOGY.....	4	and gas; Salt; Sand and gravel; Stone; Sulphur.	
Sugar; The nipa palm; Palm brandy; Starch; Coconut and coconut products; Other vegetable oils; The perfume industry, essential oils, and terpenes; Papaya gum; Tanning materials; Philippine dyes; Paper pulp; Soils.		METALLIC MINERAL RESOURCES..	23
LIMESTONE AND SILICATE INDUSTRIES		Gold; Silver and lead; Copper; Iron and iron ore; Chromic iron; Antimony.	
Portland cement; Sand-lime products; Lime; Fire clay; Vitrified and other clay products.		BACTERIOLOGY	26
NONMETALLIC MINERAL RESOURCES		BOTANY	27
Abrasive; Alum; Artesian water; Asbestos; Clay products; Cement raw materials; Coal; Producer-gas plant; Corundum; Gems and precious stones; Guano and phosphates; Gypsum; Limestone; Manganese; Mica and talc; Mineral pitch; Mineral waters; Ocher; Petroleum	15	Hat and hat making; Medicinal plants; Fungi; Coffee.	
		ENTOMOLOGY	30
		Cacao; Tobacco; Silk; Honey.	
		FISHERIES	32
		Fish ponds; Food and game fishes; Pearl fisheries; Button shells; Window shell; Trepang (bêche de mer); Shark fin; Tortoise shell; Sponges; Edible seaweed and isinglass; Fish culture; Preserving fishery products.	
		PHILIPPINE BIRDS	36
		Game birds.	
		LIBRARY	38
		AQUARIUM	38



Philippine cane strippers.

CHEMICAL TECHNOLOGY

Chemical experimentation has revolutionized the methods of mining, manufacture, and agriculture; and, as Sir William Ramsay has said, that country which is in advance in chemistry will also be foremost in wealth and general prosperity. The routine chemical work of the Bureau of Science is contributing to the development of agriculture and mining; the use of pure foods and pure drugs through the enforcement of the food and drugs act in the Philippine Islands; the classification by the Customs of various imports for the purpose of levying duty; the enforcement of the internal-revenue act and the improvement of the alcohol industry and alcoholic beverages; the investigation of forest products; the development of the local perfume, essential oil, and allied industries; the investigation of the fixed vegetable oils, coconut, lumbang, and other oils which are of commercial value; the investigation of nipa and the development of a new commercial source of sugar; the investigation of water, mineral products, soils and fertilizers, and Philippine coals and their value for use in producer-gas plants and for steam making; investigations relative to the purchase of Government supplies and standardization of materials employed for building purposes; and the development of industries for the manufacture of cement and other materials of construction from native sources. A few facts concerning the more important of these activities will be described in the following pages.

SUGAR.—The production of sugar ranks among the most important industries of the Islands. The Bureau of Science has shown that from 20 to 35 per cent of the sugar content of cane is lost in many mills in Negros, because of the antiquated methods of handling cane and juice. New mills are being built to replace the old and inefficient ones and to handle the increasing areas of growing cane. Investigations of both native and modern mills have been made by the Bureau of Science; published



Nipa swamp.

results show the financial loss due to harvesting unripe cane, and demonstrate that, if this is avoided, even in antiquated mills, an actual loss can be converted into a material gain. A test run of a small mill has been described in *The Philippine Journal of Science*. Also as a result of the work of the Bureau of Science, much of the raw sugar is now polarized before exportation and sold upon its sugar content where heretofore the valuation was all made by the purchaser upon receipt. More perfect extraction and more careful handling of the juice should increase the production and improve the quality of sugar even if there be no increase in the yield or in the planted area.

The sugar industry in the Island of Negros. *Bureau of Science publications* (No. 3); Order No. 412. Paper, \$1.25 U. S. currency.

Extraction test of a modern sugar central. *Phil. Journ. Sci., Sec. A* (1912), 7, 357-369. No. 5.

Sugar-cane experiments. *Phil. Journ. Sci., Sec. A* (1913), 8, 159-164. No. 3.

The financial loss occasioned by harvesting unripe sugar cane. *Phil. Agr. Review* (1913), 6, 340-344. No. 7.

Sugar production in the Philippines. *Merchants' Association Review*, Manila (1911), 1, 2-7. No. 7.

THE NIPA PALM.—Almost the entire insular production of alcohol—about 10,000,000 proof gallons per year—is made from the sap of the nipa palm, which grows luxuriantly in a number of places in the Philippine Islands. Although extensive nipa swamps exist in the Philippine Islands, only a few are utilized commercially. The alcohol industry has been investigated, and methods for improving the process of manufacture have been described in a number of papers from the Bureau of Science. Also, it has been discovered that a more profitable manner of utilizing the sap of this palm is in the manufacture of sugar.

It has long been known that several species of palm trees secrete a sap rich in sugar, and the natives of various countries have taken advantage of this fact, but



Provincial distillery.

no exploitation on a commercial scale has been attempted for the reason that it promised no financial returns. A thorough investigation has shown that we have in the nipa palm a source of sugar which has been proved to be very attractive from the standpoint of investment. The fresh sap has approximately the composition of that of sugar-cane sap, and the methods of collecting and preserving it during transportation to the refinery have been improved. The difficulties encountered in the establishment of the business upon a large scale have been entirely overcome through the investigation of the Bureau of Science. The production of sugar from the nipa palm is an industry new to the world and one which will be unique to the Philippine Islands; it will give a remarkable value to large areas of swamp which are otherwise almost valueless.

The alcohol industry of the Philippine Islands. Part I. A study of some palms of commercial importance with special reference to the saps and their uses. *Phil. Journ. Sci., Sec. A* (1911), 6, 110-145. No. 2.

The nipa palm as a commercial source of sugar. A consideration of the principal difficulties encountered in collecting and preserving nipa palm sap. *Phil. Journ. Sci., Sec. A* (1913), 8. No. 6.

The alcohol industry of the Philippine Islands. *Merchants' Association Review* (1911), 1, 10-12. No. 6.

PALM BRANDY.—The investigation of alcoholic beverages made from the fermented sap of the nipa and coconut palms was undertaken several years ago. Some of the beverages are excellent, and measures were undertaken to improve the general type and methods of manufacture. As the result of this work, nipa palm brandy and coconut palm brandy ought soon to find a place upon the market. These beverages have characteristic flavors due to their origin. Since beverages of this particular type will doubtless be manufactured for some time to come only in the Philippine Islands, it has been decided that those originating here may use the name of Philippine palm brandy.



Bridges connecting tuba trees.



Coconuts.

The alcohol industry of the Philippine Islands. Part II. Distilled liquors; their consumption and manufacture. *Phil. Journ. Sci., Sec. A* (1912), 7, 41-44. No. 1.

STARCH.—An investigation of a number of starch-producing plants growing in the Philippine Islands has been carried on. Among these may be mentioned tapioca or cassava (*Manihot utilissima* Pohl), the native name being camoting cahoy; arrowroot (*Maranta arundinacea* Linn.); sincamas (*Pachyrhizus erosus* Urban); the Polynesian arrowroot (*Tacca pinnatifida* Forst.); yams (*Dioscorea*; *Amorphophallus campanulatus* Blume); seeds of *Cycas circinalis* Linn.; and the sugar palm (*Arenga saccharifera* Labill.). The most promising of all these is the cassava which grows luxuriantly in various parts of the Islands and produces large quantities of starch. Twenty-seven per cent of the weight of the material can be extracted by commercial processes. The starch of the sugar palm is used by natives of certain parts of the Islands, principally the Maṅgyans, a hill tribe of Mindoro. They extract the starch from this palm, and use it as a staple article of diet. They transport it to the lowlands in baskets of palm leaves where it is sold and traded for other articles. In Mindanao the sago palm (*Metroxylon rumphii* Mart.) is of great local importance, and the commercial exploitation of the Philippine sago is a possible future development. This is the species that yields the sago of commerce, and it occurs abundantly in parts of Mindanao.

Starch production in the Philippine Islands. *Phil. Journ. Sci., Sec. A* (1908), 3, 93-98. No. 2.

The alcohol industry of the Philippine Islands. *Phil. Journ. Sci., Sec. A* (1911), 6, 200. No. 3.

COCONUT AND COCONUT PRODUCTS.—The Philippine Islands export more copra than any other country. Many investigations have been made and published on the subject. These have included the water relation of the coconut palm and that between the location of the palm and oil



Coconut grove.

content of the nuts, the hydrolysis and consequent destruction of fat, methods of drying, insect pests and preventive measures, the influence of sprouting on the copra and oil, method of analysis, effect of feeding copra cake to cattle and hogs, the purification of coconut oil and its detection as an adulterant of other oils, and the deterioration of copra during transportation. The changes which copra undergoes during transportation in the hull of a vessel have been recently studied. *Cf. Soils.*

On the water relations of the coconut palm (*Cocos nucifera*)—On the oil produced from the nuts—The factors entering into the rancidity of the oil—The insects attacking the trees. *Phil. Journ. Sci.* (1906) 1, 3–57. No. 1.

The coconut and its relation to the production of coconut oil. *Phil. Journ. Sci.* (1906), 1, 58–82. No. 1.

The keeping qualities of coconut oil and the causes of its rancidity. *Phil. Journ. Sci.* (1906), 1, 117–142. No. 2.

The principal insects attacking the coconut palm (Part I). *Phil. Journ. Sci.* (1906), 1, 143–168. No. 2.

The principal insects attacking the coconut palm (Part II). *Phil. Journ. Sci.* (1906), 1, 211–228. No. 3.

Purification of coconut oil. *Phil. Journ. Sci., Sec. A* (1908), 3, 45–47. No. 1.

Notes on the sprouting coconut, on copra, and on coconut oil. *Phil. Journ. Sci., Sec. A* (1908), 3, 111–135. No. 3.

On the detection and determination of coconut oil. *Phil. Journ. Sci., Sec. A* (1908), 3, 371–375. No. 5.

Copra spoilage on a large scale. *Phil. Journ. Sci., Sec. A* (1913), 8. No. 6.

The coconut and its products in Ceylon. *Phil. Journ. Sci., Sec. A* (1914), 9 (in preparation).

OTHER VEGETABLE OILS.—Important vegetable oils of the Philippine Islands other than coconut oil discussed above are produced from lumbang, kapok, cashew, castor bean, cotton seed, physic nut, and pili. This type of oils is also derived from oil-bearing seeds, and is of considerable importance. Lumbang oil has good drying qualities and is used in the varnish trade. The production of this



Champaca.



Ylang-ylang.

and of pili nut oil is increasing in importance. Other oils now little known may prove of commercial value.

Commercial utilization of some Philippine oil-bearing seeds: Preliminary paper. *Phil. Journ. Sci., Sec. A* (1907), 2, 439-449. No. 6.

THE PERFUME INDUSTRY, ESSENTIAL OILS, AND TERPENES.—The Philippine Islands are especially rich in plants which produce large numbers of terpenes. The most important essential oil and terpene-producing plants have been studied by the chemists of the Bureau of Science, and their commercial value discussed in *The Philippine Journal of Science*. A comprehensive investigation of the Benguet pine has shown that excellent turpentine and colophony practically identical with the products originating in America can be produced from this source. Various resins, such as elemi, balao, apitong, and copal, have been investigated to determine their chemical composition, their value in the manufacture of varnishes, etc. The essential oils responsible for the fragrance of many plants and flowers have also received considerable attention; among these are ylang-ylang, champaca, orange, lemongrass, vetiver, cinnamon, and ginger. Several of these are used in the perfume industry, and others in the manufacture of nonalcoholic beverages and fruit flavors. This work should be the basis for industries in the Philippine Islands.

The terpene oils of Manila elemi. *Phil. Journ. Sci., Sec. A* (1907), 2, 1-40. No. 1.

Philippine terpenes and essential oils, I. *Phil. Journ. Sci., Sec. A* (1908), 3, 49-64. No. 2.

Philippine terpenes and essential oils, II.—Ylang-ylang oil. *Phil. Journ. Sci., Sec. A* (1908), 3, 65-86. No. 2.

Philippine terpenes and essential oils, III. *Phil. Journ. Sci., Sec. A* (1909), 4, 93-132. No. 2.

Philippine terpenes and essential oils, IV. *Phil. Journ. Sci., Sec. A* (1910), 5, 257-265. No. 4.

New Philippine essential oils. *Phil. Journ. Sci., Sec. A* (1911), 6, 333-353. No. 4.

The fluctuation in the value of ylang-ylang oil and some of its causes. *Phil. Journ. Sci., Sec. A* (1911), 6, 355-358. No. 4.



Mangrove swamp.

Methods of rectifying ylang-ylang oil. *Phil. Journ. Sci., Sec. A* (1914), 9 (in preparation).

PAPAYA GUM.—A study of the properties of papaya gum made from the latex of *Carica papaya* has resulted in improving methods for preparing this important commercial product. The results already obtained show conclusively that gum may be made in the Philippines which is equal, if not superior, both regarding color and activity, to any now on the world's market. The constantly increasing demand for papaya gum as a substitute for pepsin and the well-known fact that satisfactory gum is difficult to obtain assure a steady market for a high-grade Philippine product.

TANNING MATERIALS.—The value of tanning materials imported into the United States has increased from 1,600,000 dollars in 1900 to 6,500,000 dollars in 1911, and tanners are becoming each year more dependent upon imported material. Bark from the better species of Philippine mangrove trees contains 30 per cent of tannin, and a net profit of from 50 pesos to 60 pesos per ton can probably be made on tanning material derived from the mangrove swamps in the Philippine Islands. There are areas or workable swamps in the Islands capable of producing yearly 1,500 metric tons of extract, having a value of 210,000 pesos. The exploitation of these swamps would involve a firewood and piling industry of about an equal magnitude. The extended use of mangrove bark and more particularly mangrove extract is comparatively a recent development. All the species of mangrove of any importance in the eastern tropics are found in the Philippine Islands, and the opportunity for a profitable cutch industry is very great.

The economic possibilities of the mangrove swamps of the Philippines. *Phil. Journ. Sci., Sec. A* (1909), 4, 205-210. No. 3

Philippine firewood. *Phil. Journ. Sci., Sec. A* (1911), 6, 1-22. No. 1,



Caña bojo suitable for paper pulp.

The economic possibilities of the mangrove swamps of the Philippines. *Phil. Journ Sci., Sec. A* (1911), 6, 45-61. No. 1.

PHILIPPINE DYES.—While it is true that the artificial dyes have largely supplanted natural materials, in some districts there occur natural dyes of sufficient brilliancy, permanency, and quantity to be very valuable. They are employed in the dyeing of native fibers for the manufacture of hats, mats, baskets, cloth, etc. A number of these dyes have been investigated and the results published.

The natural dyes and coloring matters of the Philippines. *Phil. Journ. Sci., Sec. A* (1910), 5, 439-452. No. 6.

PAPER PULP.—For several years the Bureau of Science has been investigating the suitability of bamboo, cogon grass, abaca or hemp, and various palm fibers for paper pulp. With due regard to local conditions, the data collected show that an industry of great economic value can be developed. Careful surveys of some of the available bamboo fields have been made. Sufficient data with regard to the cost of the raw material, the quantity of bamboo available, and the cost of manufacture of the pulp are given, showing that the bamboo soda pulp can be developed into a possible export trade in direct competition with chemical wood pulp at present quotations. Other countries have already utilized the information obtained from this work, and ultimately it will be the means of starting the paper industry in the Philippines. Samples of pulp manufactured from different Philippine materials can be obtained from the Bureau of Science.

Philippine fibers and fibrous substances; their suitability for paper making. *Phil. Journ. Sci.* (1906), 1, 433-463. No. 5.

Philippine fibers and fibrous substances; their suitability for paper making (Part II). *Phil. Journ. Sci.* (1906), 1, 1075-1085. No. 10.

Philippine fibers and fibrous substances; their suitability for paper making. Part III (Conclusion). *Phil. Journ. Sci., Sec. A* (1907), 2, 81-113. No. 2.



Typical Philippine limestone, Montalban Gorge.

Philippine fibers and fibrous substances; their suitability for paper making. *Phil. Journ. Sci., Sec. A* (1910), 5, 233-255. No. 4.

Bamboo for paper pulp in Bataan Province, Luzon. *Phil. Journ. Sci., Sec. A* (1912), 7, 121-123. No. 2.

Philippine citrus fruits: Their commercial possibilities and a commercial study of a few of the most important varieties. The manufacture of paper from orange pulp. *Phil. Journ. Sci., Sec. A* (1912), 7, 411-414. No. 6.

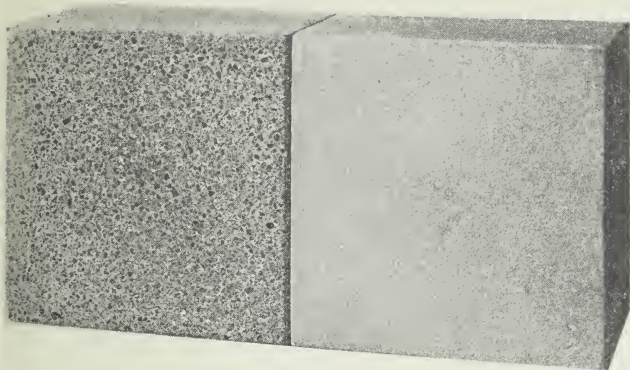
SOILS.—Data show that in general Philippine soils are highly fertile.

Philippine soils and some of the factors which influence them. *Phil. Journ. Sci., Sec. A* (1911), 6, 279-330. No. 4.

LIMESTONE AND SILICATE INDUSTRIES

Sand, limestone, and clay, although the most common, familiar, and perhaps the least appreciated of mineral resources, nevertheless constitute an asset of importance to any country. Limestones of excellent quality are abundant and of widespread occurrence throughout the Philippine Islands, and in certain localities there is also an abundance of sand, shale, or clay, the physical and chemical properties of which guarantee to this Archipelago stable industries among which the manufacture of Portland cement; quicklime; hydraulic lime; sand-lime brick and artificial stone products; building, vitrified, and fire brick; glass; roofing material; and vitrified pipes, tiles, and other ceramic products are certain to become exceedingly important.

PORTLAND CEMENT.—The imports of Portland cement during the past few years have had an average annual market value of about 1,500,000 pesos, and the local consumption is certain to increase as the country progresses in financial and industrial importance. The local manufacture of this material will not only save transoceanic freights, but also an import duty of 3.20 pesos per ton on all non-American cements. The Rizal Cement Com-



Sand-lime brick from Talim
basalt.

Sand-lime brick from Maytubig beach
sand.

pany is constructing a 1,000-barrel per day plant at Binañgonan. Excellent Portland cement has been made from several local deposits of limestone and siliceous materials. In Cebu desirable cement raw materials occur adjacent to undeveloped coal fields, the fuel from which is of suitable quality for burning cement.

Portland cement testing. *Phil. Journ. Sci., Sec. A* (1908), 3, 137-186. No. 3.

Volcanic tuff as a construction and a cement material. *Phil. Journ. Sci., Sec. A* (1908), 3, 391-407. No. 5.

Philippine raw cement materials. *Phil. Journ. Sci., Sec. A* (1909), 4, 211-229. No. 3.

Physical and chemical properties of Portland cement. Parts I and II. *Phil. Journ. Sci., Sec. A* (1910), 5, 367-413. No. 6.

The physical and chemical properties of Portland cement. Part III. *Phil. Journ. Sci., Sec. A* (1911), 6, 207-250. No. 3.

Physical and chemical properties of Portland cement. Parts IV and V. *Phil. Journ. Sci., Sec. A* (1912), 7, 135-194. No. 3.

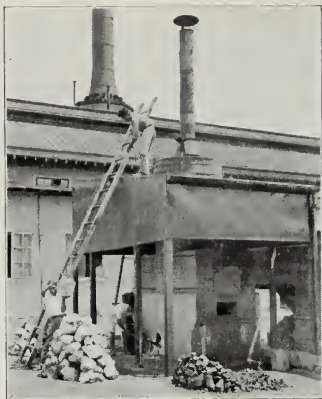
A bonus system for the purchase of Portland cement. *Phil. Journ. Sci., Sec. A* (1913), 8, 107-124. No. 2.

Philippine raw cement materials. *Mineral Resources P. I. for 1908* (1909), 32-39.

Portland cement manufacture in the Philippine Islands. *Mineral Resources P. I. for 1911* (1912), 82-96.

SAND-LIME PRODUCTS.—Conditions are very favorable in the Philippines for the commercial manufacture of brick, building blocks, tiles, slabs, marbles, and ornamental stones from sand and lime. The cost of manufacturing and selling 9-inch bricks of the best quality is estimated not to exceed 13 pesos per 1,000, which, in comparison with the price of other building materials, offers considerable margin for profits. In Germany alone over 300 sand-lime-brick factories are in constant operation.

Sand-lime brick and artificial sandstones in the Philippines. *Phil. Journ. Sci., Sec. A* (1912), 7, 317-356. No. 5: *Mineral Resources P. I. for 1912* (1913), 58.



Experimental limekiln.



Apparatus for testing road material.

LIME.—Pure coralline and crystalline limestones suitable for the manufacture of lime occur throughout the Philippine Islands. The value of the lime now produced is about 100,000 pesos per annum. It does not meet the demand in either quantity or quality, for most of the lime of local manufacture is burned in the crudest manner and seldom contains more than 25 per cent of available lime. In spite of this, it sells for about 30 pesos per ton, a price which exceeds that of Portland cement. A well-burned lime, such as is produced in the experimental kiln at the Bureau of Science, has a market value of 50 pesos per ton. If good lime were available at a moderate price, there is little doubt that the demand for it would soon equal the output of large kilns. The increasing production of sugar by modern methods is augmenting the demand for lime. It is probable that the industry would thrive best if conducted in connection with a sugar central or with a sand-lime-brick plant.

The nonmetallic minerals. *Mineral Resources P. I. for 1907-1912* (1908-1913).

FIRE CLAY.—Deposits of good fire clay suitable for the manufacture of furnace bricks are known. During the fiscal year 1913, 1,556,000 brick were imported, the market value of which was about 55,000 pesos. The greater part of this importation consisted of fire brick. The consumption will increase with the material growth of the country.

The occurrence, composition and radioactivity of the clays from Luzon, Philippine Islands. *Phil. Journ. Sci., Sec. A* (1907), 2, 413-438. No. 6.

Laguna clays. *Phil. Journ. Sci., Sec. A* (1908), 3, 377-390. No. 5.

VITRIFIED AND OTHER CLAY PRODUCTS.—Clay and shale suitable for use in the manufacture of clay products, such as building and paving brick, tile and common pottery, occur in such abundance and so generally distributed in the Philippines that they are available in practically every part of the Archipelago. No vitrified



Cold-water-paint clay.

products are manufactured here. Owing to the great expense of importing vitrified pipes, tiles, and brick, the consumption of these is small. However, vitrified brick for paving both country and city roads, vitrified pipes for drains, and tiles for floors and roofs are certain to be used in large quantities when they can be obtained at reasonable prices. In addition there is an unusually large number of deposits of kaolinitic clay which can be used as a filler in the manufacture of pipe and from which white stoneware could be manufactured; there are, also, several deposits of pure white burning kaolin. Feldspar and silica are available for blending with this clay in the manufacture of porcelain. Hydrous aluminum silicate occurs, the texture of which is similar to the amorphous colloidal clay known as fuller's earth and used for bleaching and for clarifying and filtering fats, oils, and greases. While the clay resources are practically untouched, the value of the locally manufactured products amounts to 450,000 pesos per annum. Common clay is used for crude pottery, brick, and tiles; white clays are used in minor quantities for pottery and in the manufacture of cold-water paint.

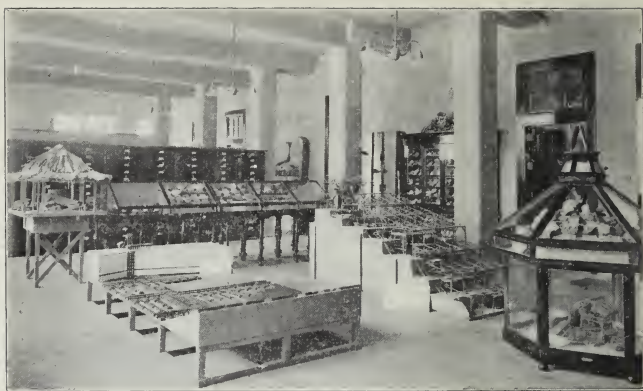
Philippine pottery. *Phil. Journ. Sci., Sec. A* (1910), 5, 143-154. No. 2.

The nonmetallic minerals. *Mineral Resources P. I. for 1907-1912* (1908-1913).

NONMETALLIC MINERAL RESOURCES

The value of the nonmetals exclusive of coal is more than 2,000,000 pesos per annum, and, although less conspicuous, is about twice as great as the value of the metals produced.

ABRASIVES.—Stone mills for grinding corn by hand are manufactured in several provinces, although the value of the annual production of the industry is not great. Limestone is the most widely used mill stone, while probably the best mills are made from an andesite in Rizal Province.



Mining exhibit room, Bureau of Science.

In Ilocos Sur, a calcareous sandstone is used for this purpose.

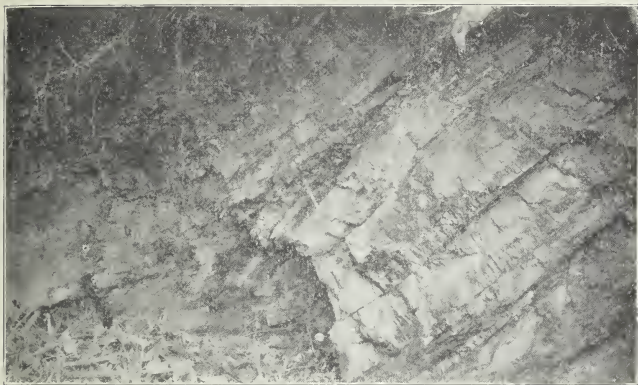
Certain schists, fine sandstones, and felsites are used in different parts of the Islands for sharpening knives and bolos. The material for these whetstones is generally obtained locally, although a bluish green schist found near Lucena, Tayabas, is exported to neighboring towns and provinces. A fine siliceous powder has been found on Panay Island; near Olongapo, Luzon; and at other places, which is very similar to the material known as tripoli which is mined and sold in America for polishing and filtering purposes. This powder has been used locally for polishing brass.

✓ **ALUM.**—Alum incrustations are abundant around many volcanic vents. The most common form is alunite or alumstone. The Philippine deposits could be made to yield a considerable supply of this substance.

ARTESIAN WATER.—Water-bearing sandstones, limestones, and tuff (consolidated volcanic ash) are widespread in the Philippines, affording a source of healthful uncontaminated water. Geologic investigations carried on by the Bureau of Science show the distribution and positions of these strata. The value of pure water in the economy of the Philippines is not rivalled by that of any other mineral substance. The Bureau of Public Works has drilled to date 858 successful wells capable of yielding on an average 150 liters per minute. Calculated at the rate paid for pure water in Manila and excluding proper charge for bottling and delivery, the value of the possible annual production would be, approximately, 5,000,000 pesos, or about twice the total value of all the other mineral products. Soft water is available from the deep-seated sources penetrated by artesian boring, and the use of soft instead of hard water in any industry is a valuable asset.

Ground-water resources of the Philippine Islands. *Phil. Journ. Sci., Sec. A* (1914), 9 (in preparation).

Miscellaneous nonmetallic mineral products. Part I. *Mineral Resources P. I. for 1909* (1910), 51–52.



Uling coal seam.

ASBESTOS.—Asbestiform minerals are widespread in the Philippines. They occur associated with serpentine which has been found in Ilocos Norte, Bataan, Antique, and Albay Provinces, and probably in many other localities. No noteworthy quantity of true asbestos, or chrysolite, has yet been found, but the indications are promising.

The asbestos and manganese deposits of Ilocos Norte, with notes on the geology of the region. *Phil. Journ. Sci., Sec. A* (1907), 2, 145–177. No. 3.

CLAY PRODUCTS.—*Cf.* Fire clay; vitrified and other clay products, page 14.

CEMENT RAW MATERIALS.—*Cf.* Limestone and silicate industries; Portland cement, page 12.

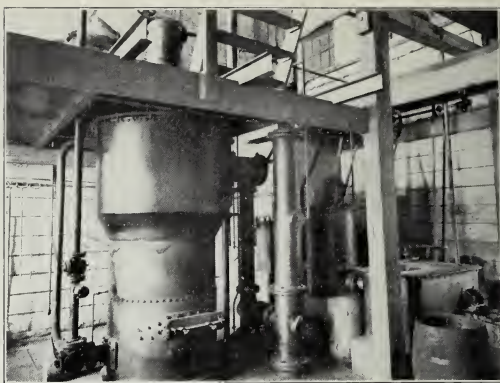
COAL.—Almost every island in the Philippine Archipelago and a majority of the provinces are known to contain coal. The Bureau of Science has accumulated data concerning the quantity and quality of the coal in the different coal fields which enables it to make intelligent estimates of the recoverable tonnages of the different grades. In quality the coal ranges from black lignite to semianthracite. Conservative estimates show that there is “in sight” at least 3,500,000 tons of black lignite and 1,000,000 tons of subbituminous coal, while the probable tonnage is: Black lignite, 26,500,000; subbituminous, 31,500,000; bituminous or semianthracite, 3,500,000. The possible tonnages are great. The largest annual (1909) production to date is 30,336 metric tons valued at 197,184 pesos. Owing chiefly to lack of development, the production has declined since 1909. Coking coal occurs in Cebu and Bulacan Provinces, but the seams have not yet been proved economically important.

Philippine coals and their gas-producing power. *Phil. Journ. Sci.* (1906), 1, 877–902. No. 8.

The proximate analysis of Philippine coals. *Phil. Journ. Sci., Sec. A* (1907), 2, 41–66. No. 1.

The geology of the Compostela-Danao coal field. *Phil. Journ. Sci., Sec. A* (1907), 2, 377–405. No. 6.

The relationship between the external appearance and the ash content of Philippine coal. *Phil. Journ. Sci., Sec. A* (1908), 3, 91–93. No. 2.



Producer-gas plant at the Bureau of Science.

Coal in the Cagayan valley. *Phil. Journ. Sci., Sec. A* (1908), 3, 535-537. No. 6.

Calorimetry, and the determination of the calorific value of Philippine and other coals from the results of proximate analysis. *Phil. Journ. Sci., Sec. A* (1909), 4, 171-204. No. 3.

Chemical and physical characteristics of Philippine coal. *Phil. Journ. Sci., Sec. A* (1912), 7, 1-18. No. 1.

The oxidation and deterioration of coal. *Phil. Journ. Sci., Sec. A* (1912), 7, 297-316. No. 5.

Summary of the chief characteristics of Philippine coals. *Mineral Resources P. I. for 1907* (1908), 34-39.

Philippine coal. *Mineral Resources P. I. for 1909* (1910), 36-40.

Coal in the Cagayan valley. *Mineral Resources P. I. for 1909* (1910), 41-42.

The coal resources of the Philippine Islands. *Mineral Resources P. I. for 1910* (1911), 37-56.

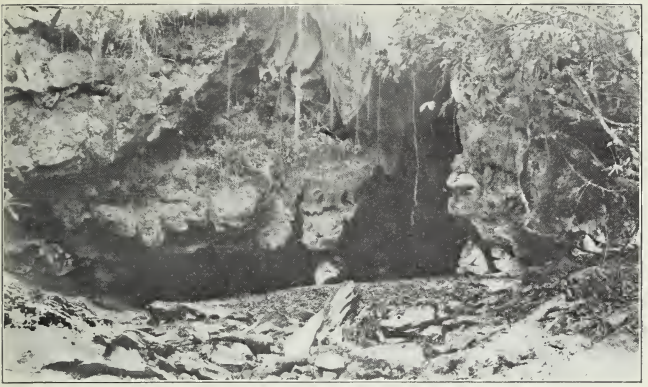
Coal resources of the Philippines. *Mineral Resources P. I. for 1911* (1912), 54-62.

The coal deposits of Batan Island. *Bull. P. I. Min. Bur.* (1905), 5, 1-56.

PRODUCER-GAS PLANT.—Granting the usefulness of Philippine coal for steaming purposes, it is several times as efficient to convert this coal into producer gas for use in a gas engine for the production of electric power as to burn the coal under the boilers for the production of steam with which to operate dynamos. The new dynamo at the Bureau of Science direct coupled to a producer-gas engine is unquestionably far more economical in operating expenses than the generator steam units. The rated capacity of the dynamo is 50 kilowatts; using Batan coal in the gas generator the coal consumption is 1½ kilograms per net kilowatt hour when the load factor is 68.3 per cent. This information is extremely important to industries requiring motive power.

Philippine coals and their gas-producing power. *Phil. Journ. Sci.* (1906), 1, 877-902. No. 8.

Chemical and physical characteristics of Philippine coal. *Phil. Journ. Sci., Sec. A* (1912), 7, 1-17. No. 1.



Guano cave.

CORUNDUM.—Corundum pebbles have been found in the alluvials of Nueva Ecija. Corundum is an important constituent of emery.

GEMS AND PRECIOUS STONES.—Specimens of agate, opal, and amethyst have been found in the Islands which indicate that valuable ornamental stones may be found here in quantity if diligent search is made for them.

GUANO AND PHOSPHATES.—Guano occurs in limestone caves in nearly every province. Studies made by the Bureau of Science show the guano from many localities to be valuable for fertilizing purposes.

An area of leucite-tephrite, a potash-bearing rock, which may sometime become a source of potash, has been discovered and mapped by the Bureau of Science. This rock occurs near Aroroy, Masbate.

Apatite, a calcium phosphate, is found in Ilocos Norte, and is a possible source of phosphates.

Philippine guano. *Phil. Journ. Sci., Sec. A* (1912), 7, 195–199. No. 3.

GYP SUM.—Large specimens of gypsum have been received by the Bureau of Science from the barrio of Talajib near Loboo, Batangas Province, Luzon. It is probable that it exists there in commercial quantities. The occurrence of gypsum crystals around volcanic fumaroles has been often noted from which a fair supply might be obtained.

LIMESTONE.—*Cf.* Lime, page 14.

MANGANESE.—Manganese occurs as psilomelane, pyrolusite, and wad in Ilocos Norte, Pangasinan, Bulacan, Tarlac, and Masbate. The manganiferous ores are found at other places in intimate association with gold-bearing calcite and quartz veins. No production is reported to date, although some of the deposits warrant exploration. An analysis of a manganese nodule from Masbate showed a content of 44 ounces of silver per ton.

Manganese deposits of the Philippine Islands. *Mineral Resources P. I. for 1911* (1912), 42–47.



Bahay oil derrick No. 2.



Toledo, Cebu, oil derrick.

MICA AND TALC.—Undeveloped deposits of mica and talc exist in Ilocos Norte and at other localities.

Asbestos and manganese deposits. *Phil. Journ. Sci., Sec. A* (1907), 2, 172-173. No. 3.

MINERAL PITCH.—One of the mineral pitches known as gilsonite has been discovered in a sandstone formation in the northern part of Leyte. Asphalt has been reported from the mountains northeast of Manila.

The production of nonmetals in 1912. *Mineral Resources P. I. for 1912* (1913), 46.

MINERAL WATERS.—Mineral waters valuable for medicinal purposes issue from springs at many places in the Archipelago. In Laguna, Bulacan, Cebu, Albay, Camarines, and other provinces, mineral waters are utilized for baths at health resorts. In Bulacan and Laguna Provinces, mineral waters are bottled and sold to the value of 60,000 pesos per annum. Analyses of mineral waters from the most important springs are on file in the Bureau of Science.

The nonmetallic minerals. *Mineral Resources P. I. for 1907-1912* (1908-1913).

UCHER.—In the past, deposits of limonite have been worked in Ilocos Norte, and red and yellow ochers have been prepared by burning, which have found a limited market in Manila. Cheap red and yellow paints could be profitably made from this material. Deposits of limonite which could be utilized for this purpose undoubtedly exist in many parts of the Philippines.

Asbestos and manganese deposits. *Phil. Journ. Sci., Sec. A* (1907), 2, 173. No. 3.

PETROLEUM AND GAS.—Petroleum is known to occur in Tayabas, Cebu, Iloilo, Capiz, and Leyte Provinces. Bondoc Peninsula in Tayabas Province has been studied in detail by the Bureau of Science and pronounced worthy of exploration by drilling. The other fields have not been



Salinas, Nueva Vizcaya, salt spring.

studied in detail, but are considered promising. Samples analyzed show that the oils have a paraffin base and are practically free from sulphur and will prove very useful if they can be obtained in sufficient quantities. Natural gas occurs with the petroleum, and also has been encountered in Albay and Pampanga Provinces.

The geology and petroleum resources of the southern part of Bondoc Peninsula, Tayabas Province. *Phil. Journ. Sci., Sec. A* (1913), 8. No. 5.

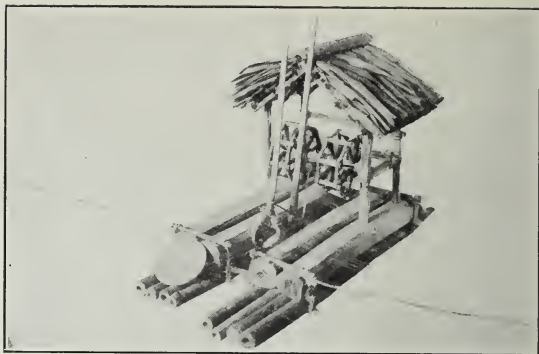
Petroleum on Bondoc Peninsula, Tayabas. *Mineral Resources P. I. for 1912* (1913), 49.

SALT.—The salt manufactured in the Philippine Islands each year is valued at more than 500,000 pesos. Sea water evaporated by solar heat is the source of the larger part of this production, but in certain localities, notably north-central Luzon, brine from salt springs is utilized. The Bureau of Science has devoted much study to this industry, and has suggested means for improving and increasing the output.

The salt industry and resources of the Philippine Islands. *Mineral Resources P. I. for 1911* (1912), 63–75.

Salt industry and resources of the Philippine Islands. *Merchants' Association Review* (1911), 1, 2–8. No. 10.

SAND AND GRAVEL.—Approximately one-half million pesos' worth of sand and gravel are produced and used in the Philippine Islands every year. Streams and beaches throughout the Islands are the sources of these materials, which are used principally for road building and bridge construction. The most common sand is made up of feldspathic and ferromagnesian mineral and rock fragments, although large deposits of quartz sand are known. Sand which is suitable for glass making is encountered at Paracale, Camarines, and at Baguio, Mountain Province. At Paracale, the sand occurs in a bed about 4 meters thick, while at Baguio the deposits are siliceous sinter and are of great extent. Sand suitable for molds and cores for iron castings is obtained locally by the Manila foundries.



Model of a native dredge used in Paracale in Spanish times.

Sand, gravel and crushed stone available for concrete construction in Manila. *Phil. Journ. Sci., Sec. A* (1909), 4, 463-479. No. 5.

Concrete construction in Manila and the Philippine Islands. *Phil. Journ. Sci., Sec. A* (1910), 5, 117-141. No. 2.

Miscellaneous nonmetallic mineral products. Part I. *Mineral Resources P. I. for 1909* (1910), 47.

Road materials of the Philippine Islands. *Merchants' Association Review* (1911), 1, 1-5. No. 8.

STONE.—Although concrete is used almost exclusively for fire-resisting structures in the Philippines, the stone quarried is worth more than 600,000 pesos per year. The chief demand is for crushed stone for concrete and road material and rough stone for riprap and the basal course of first-class roads. Marble suitable for decorative purposes is found at several places, the most available deposit being at Romblon, Capiz Province. Stone suitable for building purposes could be quarried at a great many places should a demand arise for it. A lithographic limestone near Angat, Bulacan, is being exploited commercially.

Volcanic tuff as a construction and a cement material. *Phil. Journ. Sci., Sec. A* (1908), 3, 391-407. No. 5.

The marble and schist formations of Romblon Island. *Phil. Journ. Sci., Sec. A* (1909), 4, 87-89. No. 1.

Sand, gravel and crushed stone available for concrete construction. *Phil. Journ. Sci., Sec. A* (1909), 4, 475-479. No. 5.

Sand-lime brick and artificial sandstones in the Philippines. *Phil. Journ. Sci., Sec. A* (1912), 7, 317-355. No. 5.

The stone industry at San Esteban, Ilocos Sur. *Phil. Journ. Sci., Sec. D* (1912), 7, 213-229. No. 4.

Miscellaneous nonmetallic mineral products. Part I. *Mineral Resources P. I. for 1909* (1910), 44-47.

SULPHUR.—Sulphur in a more or less pure state occurs at many places throughout the Archipelago, principally near active or extinct volcanoes. The principal localities are Biliran Island (north coast of Leyte); Burauen, Leyte; Camiguin Island (northern); Pocdol Mountains, Sorsogon; Ifugao subprovince, Luzon; Mount Apo, Minda-



Gold-dredge construction in Paracale.

nao; and Taal Volcano, Luzon. At the first two localities it has been estimated that there are 3,000 tons or more available. It is probable that, considering the sulphur-permeated rocks as well as the pure native sulphur about the solfataras, there are several localities where this mineral exists in commercial quantities.

Sulphur deposits in the Philippine Islands. *Mineral Resources P. I. for 1911 (1912)*, 76-81.

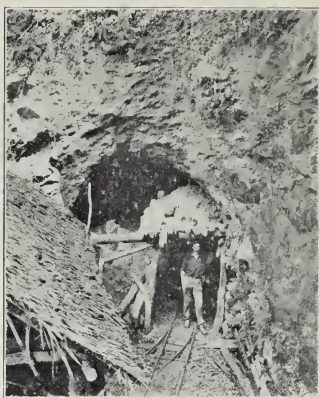
METALLIC MINERAL RESOURCES

GOLD.—The production of gold is steadily increasing. In 1912 the output was worth 1,140,000 pesos, and for 1913 it will be increased by nearly 50 per cent. The major portion has been produced from dredging. Dredges are operating at present only at Paracale, Gumaus, and Malaguit, Ambos Camarines. At Paracale it is estimated there are 1,200 hectares of placer and nearly 2,000 at Malaguit and Gumaus. This entire ground should average 90 centavos per cubic meter.

Two dredges are being built for Paracale, two for Malaguit, one for Umerai, Tayabas, and one for Mariquina, Rizal. A hydraulic plant is being installed at Cansuran, Surigao.

Large areas of placer ground are found on the Abra and Agno Rivers, Mountain Province; in Pangasinan; Nueva Ecija; Tayabas; Bulacan; Mindero; Misamis; Surigao; and along the Agusan River, Mindanao. Altogether, from 800 to 1,000 square kilometers of placer ground can be found in the Philippines as yet untouched by a dredge. One-half of this area will probably average over 40 centavos a cubic meter and should yield a handsome profit.

One quartz mine, the Colorado mine in Masbate, produces about 2,000 pesos' worth of gold per day at a cost of about 1,000 pesos. None of the other mills in the Archipelago have so far been very successful. Two new mills are being erected in Masbate. The districts where



Upper level of the Colorado mine,
Masbate.

Headwaters gold-extraction mill.

gold-quartz mining has been carried on are Baguio, Mountain Province; Paracale, Ambos Camarines; and Aroroy, Masbate.

Gold-bearing veins are very numerous. In the districts enumerated there are about 60 veins that probably average from 8 to 20 pesos per ton.

Reconnaissance surveys have shown that gold occurs in practically every part of the Philippine Islands. Many places show promise of valuable deposits that have as yet been unexplored and undeveloped.

The geology and mineral resources of the Aroroy district, Masbate. *Phil. Journ. Sci., Sec. A* (1911), 6, 413-421. No. 5.

Additional notes on the economic geology of the Baguio mineral district. *Phil. Journ. Sci., Sec. A* (1911), 6, 429-447. No. 6.

Ore deposits of the Philippine Islands. *Phil. Journ. Sci., Sec. A* (1913), 8, 81-105. No. 2.

Alteration and enrichment in calcite-quartz-manganese gold deposits in the Philippine Islands. *Phil. Journ. Sci., Sec. A* (1913), 8, 125-134. No. 2.

The gold fields of the Surigao Peninsula, Mindanao. *Mineral Resources P. I. for 1908* (1909), 40-44.

The gold district of Paracale-Mambulao, Ambos Camarines. *Mineral Resources P. I. for 1909* (1910), 9-13.

The Baguio mineral district. *Mineral Resources P. I. for 1909* (1910), 14-17.

The Aroroy mining district. *Mineral Resources P. I. for 1909* (1910), 18-25.

Gold placers of Nueva Ecija. *Mineral Resources P. I. for 1909* (1910), 26-28.

Report on the auriferous deposits of the Second District of the Department of Mindanao, Misamis. *Mineral Resources P. I. for 1909* (1910), 62-71.

Paracale-Mambulao mining district. *Mineral Resources P. I. for 1910* (1911), 18-25.

Philippine placers. *Mineral Resources P. I. for 1910* (1911), 69-72.

The Aroroy mining district, Masbate. *Mineral Resources P. I. for 1911* (1912), 11-18.

Cansuran mining district. *Mineral Resources P. I. for 1911* (1912), 27-31.

The black sands of Paracale. *Mineral Resources P. I. for 1911* (1912), 34-38.



Colorado gold-extraction mill.

The Aroroy district. *Mineral Resources P. I. for 1912* (1913), 25.

Other districts (gold). *Mineral Resources P. I. for 1912* (1913), 33.

Progress in winning gold. *Merchants' Association Review* (1911), 1, 1-5, 11. No. 11.

SILVER AND LEAD.—Silver is found alloyed with the gold in practically all of the gold deposits in the ratio of 1 part silver to 4 parts gold. Silver is found associated with galena in Bulacan, Paracale, Cebu, Marinduque, and Mindanao. The deposit in Marinduque was worked for a short time, but at present the mine is shut down. Some of the above deposits should prove to be valuable.

Some native silver has been reported.

The metallic mineral resources of the Philippine Islands. *Mineral Resources P. I. for 1908* (1909), 28.

COPPER.—The copper deposits at Mancayan, Mountain Province, have been worked for years, and large amounts of high-grade ore have been shipped out. Very little of such ore is left above the lowest workings, which are about 50 meters below the outcrop. The deposit is about 100 meters wide, and can be traced for 16 kilometers along the surface. It appears to be a mineralized quartz porphyry. Some portions have been enriched by deposits of secondary copper. The main body is low grade, but a large part of it might be profitably worked. A railroad from the coast would make this property very valuable, but the expense would be great.

Other copper deposits have been found in Benguet, Pangasinan, Batangas, Mindoro, Masbate, Panay, and Mindanao. Very little is known about any of these.

Native copper has been found in Milagros, Masbate. Its value has not been determined. Native copper is also found in the placer deposits of Paracale and Malaguit, Ambos Camarines.

The Mancayan-Suyoc district, Mountain Province. *Mineral Resources P. I. for 1909* (1910), 30-31.



Angat iron-ore smelter.



Philippine plowshares.

A preliminary reconnoissance of the Mancayan-Suyoc mineral region, Lepanto, Luzon, P. I. *Bull. P. I. Min. Bur.* (1905), 4, 1-58.

IRON AND IRON ORE.—Valuable deposits of high-grade hematite and magnetite are found in the Eastern and Southeastern Cordilleras of Luzon. The four principal deposits lie near the towns of Sibul Springs and Angat, Bulacan Province; Santa Inez, Rizal Province; and Mambulao, Camarines Province. These deposits are undeveloped, but the ore occurring as boulders on the surface of the ground in Bulacan and Rizal Provinces amounts to 5,000,000 metric tons, while the same statement would probably hold true for the deposit near Mambulao, Camarines. The iron produced annually from the Bulacan ores by native smelters amounts to 140 metric tons valued at 49,000 pesos, and represents the metal recovered from 350 tons of iron ore. Other iron deposits are known, but their extent is not determined.

Geology of Bulacan; iron deposits. *Phil. Journ. Sci., Sec. A* (1914), 9 (in preparation).

The Bulacan iron deposits. *Mineral Resources P. I. for 1909* (1910), 32-33.

Iron in the Philippines. *Mineral Resources P. I. for 1910* (1911), 57-60.

The iron industry in 1911. *Mineral Resources P. I. for 1911* (1912), 39-41.

Report on a geological reconnoissance of the iron region of Angat, Bulacan. *Bull. P. I. Min. Bur.* (1903), 3, 1-62.

CHROMIC IRON.—Chromic iron or chromite has been discovered in promising quantities in Antique Province, Panay.

ANTIMONY.—Specimens of antimony have been found in Batangas Province, but no development has been carried on.

BACTERIOLOGY

The Bureau of Science has conducted medical surveys in various parts of the Archipelago to determine the

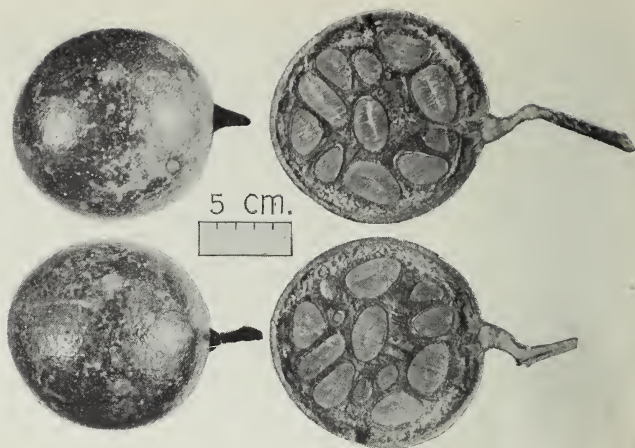


Hat making in the Philippines.

kinds of diseases and their prevalence. These diseases were studied with reference to their etiology, pathology, treatment, immunity, and prevention. Investigations were made of the diagnosis, transmission, pathology, and treatment of epidemic diseases, and the Philippine Islands have been practically freed from them. Bacteriological examinations of artesian wells and other waters and similar biological work have assisted and are assisting in the industrial development of the Archipelago. The preparation and sale of sera and vaccines (a very important function on account of the difficulty of securing such products from Europe or America) has made these products as available here as they are in the United States. The biological laboratory will continue its systematic studies, and stands ready to assist in solving the bacteriological problems connected with the industries being developed.

BOTANY

The work of the botanists of the Bureau of Science is assisting accurately to classify the timber trees of the Philippines, of which there are about 2,500 different species, and to enable the foresters by the use of this information to reduce the infinite number of native names to selected standard names; to supply similar data to other bureaus such as the Bureaus of Agriculture and Education, to help in the selection, propagation, and care of ornamental plants and shade trees; as well as to gather accurate knowledge of the names, properties, and relationships of the thousands of plant species growing in the Archipelago. More than 7,000 species of plants from the Philippines are already known. Correct botanical identifications precede the utilization of many forest products, the development of the economic properties of plants, and many other classes of work. A great deal of the botanical work has an extended practical significance, and some of the economic phases are discussed in the foregoing and following paragraphs.



St. Ignatius bean.

A flora of Manila. *Bureau of Science publications No. 5*;
Order No. 419. Paper, \$2.50 U. S. currency.

Indo-Malayan woods. *Phil. Journ. Sci., Sec. C* (1909), 4,
409-592. No. 4.

HAT AND HAT MAKING.—The Bureau of Science has published data on the types and grades of Philippine hats, the materials of which they are made, how the materials are prepared, where they are secured, and the centers of the hat-making industry. The manufacture and exportation of hats from the Philippine Islands is a comparatively large industry.

Philippine hats. *Phil. Journ. Sci., Sec. C* (1911), 6,
93-131. No. 2.

MEDICINAL PLANTS.—A very large number of plants are used by Filipinos in the treatment of diseases. *Datura*, dita, sibucan, macabuhay, bonduc, purging oils, and the fish and arrow poisons have been studied. A few of these are recognized as sources of various medicines in the standard pharmacopœia. The active constituents of many medicinal plants growing in the Archipelago have been isolated and identified.

There are very few commercial species. A single medicinal plant is commercially important for export at the present time and that is the St. Ignatius bean (*Strychnos ignatii* Berg.) yielding strychnine and brucine, the species being found native only in the Philippines. The castor oil plant, croton oil plant, kamala, and *datura* (as a source of atropine) are very little or not at all utilized although all grow very luxuriantly and are very abundant. The potential commercial medicinal plants are many, but the industry must be developed by individuals. The Bureau of Science will gladly supply data with regard to specimens submitted.

The physiologically active constituents of certain Philippine medicinal plants. *Phil. Journ. Sci.* (1906), 1,
1007-1036. No. 10.

The commercial preparation and medicinal properties of papain from *Carica papaya*. *Phil. Journ. Sci., Sec. A*
(1914), 9 (in preparation).



Sampaloc tree.



Coffee tree.

The physical and chemical properties of the oleoresin of *Aspidium* with respect to the detection of adulterations. *Phil. Journ. Sci., Sec. B* (1913), 8, 523-538. No. 6.

FUNGI.—Most crops are subject to the ravages of plant diseases, and many of those occurring in the Philippine Islands have been studied and means provided for their prevention, eradication, and cure, so that when difficulties are experienced with red-rot, coffee blight, or diseases of any cultivated plants the Bureau of Science should be communicated with.

Fungi philippinenses. *Phil. Journ. Sci., Sec. C* (1910), 5, 163-166. No. 2.

Factors influencing fungus succession on dung cultures. *Phil. Journ. Sci., Sec. C* (1913), 8, 21-29. No. 1.

Descriptions of some new Philippine fungi. *Phil. Journ. Sci., Sec. C* (1913), 8, 195-196. No. 3.

Enumeration of Philippine fungi with notes and descriptions of new species. Part I: Micromycetes. *Phil. Journ. Sci., Sec. C* (1913), 8, 265-285. No. 4.

Enumeration of Philippine fungi with notes and descriptions of new species, II. *Phil. Journ. Sci., Sec. C* (1913), 8, 475-508. No. 6.

COFFEE.—Thirty odd years ago coffee was an exceptionally prolific source of revenue to the people of Batangas and neighboring provinces. Millions of pesos flowed into the Islands from that product alone. A lack of information regarding the pests of this plant and a consequent neglect to protect it from insect and other diseases have caused the absolute abandonment of coffee culture in that and nearby regions.

Coffee grows most luxuriantly in Bontoc, Benguet, Ilocos Norte, and in Bukidnon subprovince, Agusan Province. The one drawback in these regions is the presence of the Ceylon coffee blight, a disease caused by a microscopic parasitic fungus growing on the leaves of the plant, which can be controlled, however, by the proper use of Bordeaux mixture.



Silk-house interior, showing silkworms on ant-proof racks.

ENTOMOLOGY

CACAO.—Ten years ago cacao from the Philippine Islands obtained the grand prize at the St. Louis Exposition. In color, shape, body, and texture the beans shown were superior to the product of any other country.

Two kinds do well here, the red or forastero and the white. The latter is less subject than the former to the attacks of the pod moth, an insect which has so far been found only in Palawan.

If properly cultivated, pruned, protected from the effects of typhoons, and kept free from insect pests as outlined by the Bureau of Science, cacao would be one of the most profitable permanent crops raised in these Islands.

A preliminary bulletin on insects of the cacao, prepared especially for the benefit of farmers. *Pub. Bur. Government Laboratories* (1903), No. 11, 7-58.

TOBACCO.—The value of Philippine tobacco and cigars would be enhanced several hundred per cent to the grower and manufacturer in these Islands were the wrapper for the finer grades raised here.

Repeated experiments on varying scales both by private companies and the Government demonstrated that excellent "Sumatra wrapper" can be grown here if proper protection be given in the field and warehouse against insect attacks.

Philippine cigars of all grades have been rejected in the European and American markets owing to their being worm eaten (*picado*). It has been demonstrated by the Bureau of Science that 100 per cent immunity from these pests can be assured if the manufacturer will properly protect his stock of raw and prepared tobacco while in the factory.

Problems in economic entomology in the Philippines. *Phil. Journ. Sci.* (1906), 1, 1070. No. 10.

The cigarette beetle (*Lasioderma serricorne* Fabr.) in the Philippine Islands. *Phil. Journ. Sci., Sec. D* (1913), 8, 1-42. No. 1.



Wild bees in Cementerio del Norte.



The deserted comb.

SILK.—The mulberry silkworm, while originally a temperate zone insect, has by careful selection through several years of experimentation become thoroughly acclimated in countries like southern India, Ceylon, and the Philippines.

The Bureau of Science has demonstrated that the Bengal-Ceylon and the Philippine races of silkworms yield an excellent quality of silk and produce a generation of worms every forty-five days. Silkworms are not attacked by diseases in the Philippines. Their food, the mulberry, grows most luxuriantly in all parts of the Islands, and is free from pests. Three crops of leaves can be taken off a given area of mature trees (4 years old) each year. A hectare of trees (1,100) will feed about three million silkworms per annum, and leaves may be harvested at the end of two years after cuttings have been planted.

Nipa-roofed sheds with sides of sauale and sinamay are adapted to housing the silkworms. The work of silk culture can be done by women and children.

For years to come all of the silk produced in the Philippines will find a local market.

The gross income from a hectare of mulberry trees would vary from 4,500 to 6,000 pesos a year. After deducting interest on the investment and the cost of cultivation, manufacture, and marketing, a minimum profit of 2,000 pesos would appear to be assured to any one engaging in silk culture with an investment of 15,000 pesos for land and equipment.

A manual of Philippine silk culture. *Bureau of Science publications* (No. 4); Order No. 413. Paper, \$0.75 U. S. currency.

HONEY.—Wild honey is plentiful in all the wooded portions of the Philippines, and a considerable trade is carried on in honey and wax collected by the crudest methods. Philippine honey bees produce an excellent grade of honey. Bee culture could be carried on in connection with farming. Even at present a couple of thousand pesos' worth of honey is imported each year,



Rompecandado.

indicating an ample local market for the native product. Efforts to import honey bees from the temperate zone have not been entirely successful.

FISHERIES

FISH PONDS.—The value of the fish ponds in the vicinity of Manila is about 6,000,000 pesos. There are also extensive ponds in various other localities in the Islands. These ponds in many cases serve a two-fold purpose—the growing of the ordinary market fish, bañgos, and the manufacturing of salt—each being a profitable industry.

The fishery resources of the Philippine Islands. Part I.—Commercial fishes. *Phil. Journ. Sci., Sec. A* (1908), 3, 519–520. No. 6.

FOOD AND GAME FISHES.—Next to agricultural products, food fishes are of the greatest importance to the Filipino people. In Manila alone fresh fish to the value of over 5,000 pesos are sold each day. Sixteen hundred species of fishes from Philippine waters have been identified, and with a few exceptions they are all used as food. Such fishes as the anchovy, sardine, and herring abound and constitute a potential source of wealth.

Game fishes abound in many places in the Islands; the Jew fish, the bonita, the sword fish, and tuna afford the best sport.

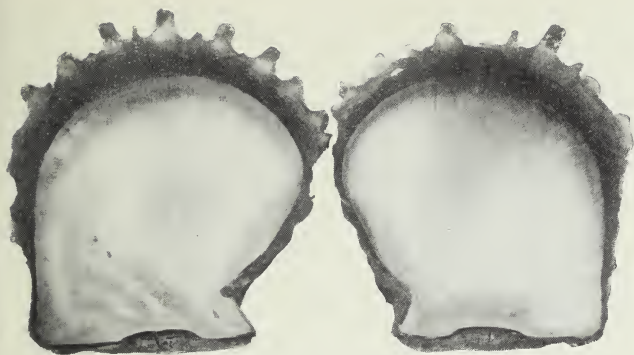
A check-list of Philippine fishes. *Bureau of Science publications No. 1*; Order No. 102. Paper. \$0.75 U. S. currency.

The fishery resources of the Philippine Islands. Part I.—Commercial fishes. *Phil. Journ. Sci., Sec. A* (1908), 3, 513–531. No. 6.

New species of Philippine fishes. *Phil. Journ. Sci., Sec. A* (1909), 4, 491–543. No. 6.

Descriptions of four new species of fishes from Bantayan Island, Philippine Archipelago. *Phil. Journ. Sci., Sec. D* (1910), 5, 115–119. No. 2.

The successful transference of black bass into the Philippine Islands, with notes on the transportation of live fish long distances. *Phil. Journ. Sci., Sec. D* (1910), 5, 153–159. No. 3.



Pearl shell of the Philippines.

The fishery resources of the Philippine Islands. Part IV. Miscellaneous marine products. *Phil. Journ. Sci., Sec. D* (1911), 6, 283-320. No. 6.

Description of a new *Acanthocybium* from the Philippine Islands. *Phil. Journ. Sci., Sec. D* (1912), 7, 283-287. No. 4.

PEARL FISHERIES.—Pearl shell to the amount of 292,211 kilograms, valued at 354,260 pesos, was exported during 1913, the number of pearls secured during the year was above the average, and the price paid by dealers was high. Fifty-two pearling boats are now operating in Moro Province. The pearl fisheries are proving to be a very attractive field of investment, especially for Japanese capital.

The fisheries resources of the Philippine Islands. Part III. Pearls and pearl fisheries. *Phil. Journ. Sci., Sec. D* (1910), 5, 87-101. No. 2.

The pearl fishery of Bantayan. *Phil. Journ. Sci., Sec. D* (1910), 5, 149-151. No. 3.

BUTTON SHELLS.—The increasing demand for shells for the manufacturing of pearl buttons, particularly for the top shell (*Trochus*) and the turban shell (*Turbo*), has stimulated the gathering of them by fishermen. The amount of these shells exported during the last year was 738,025 kilograms valued at 287,120 pesos.

The fishery resources of the Philippine Islands. Part IV. Miscellaneous marine products. *Phil. Journ. Sci., Sec. D* (1911), 6, 300-305. No. 6.

WINDOW SHELL.—About 5,000,000 window shells are used each year in the building operations in the city of Manila, a large proportion of which come from the beds Manila Bay. The demand for these shells in other countries, for making windows, lamp shades, and screens, is steadily growing. The Bureau of Science is making an effort to increase their cultivation.

The fishery resources of the Philippine Islands. Part IV. Miscellaneous marine products. *Phil. Journ. Sci., Sec. D* (1911), 6, 296-300. No. 6.

TREPANG (BÊCHE DE MER).—The preparation and exportation of trepang from the Philippines gives em-



Button shell (top shell).

ployment to a considerable number of fishermen, the average amount secured per year being about 287,473 kilograms valued at 130,876 pesos. The industry could be greatly increased.

The fishery resources of the Philippine Islands. Part IV. Miscellaneous marine products. *Phil. Journ. Sci., Sec. D* (1911), 6, 283-289. No. 6.

SHARK FIN.—The annual exportation of shark fin, which is dried and used for food in China, amounts to 175,000 pesos per year. This amount could be easily doubled or trebled.

The fishery resources of the Philippine Islands. *Phil. Journ. Sci., Sec. D* (1911), 6, 289-291. No. 6.

TORTOISE SHELL.—Twenty-four hundred eighty-five kilograms of tortoise shell valued at 36,402 pesos were exported from the Philippines in 1913. The manufacture of tortoise shell articles in these Islands would be an attractive investment requiring but small capital.

The fishery resources of the Philippine Islands. *Phil. Journ. Sci., Sec. D* (1911), 6, 291-295. No. 6.

SPONGES.—Sponges of good quality are found in the Moro Province and offer an attractive field for small capital. Cheap sponges for use about automobiles could be easily supplied.

The fishery resources of the Philippine Islands. II. Sponges and sponge fisheries. *Phil. Journ. Sci., Sec. A* (1909), 4, 57-65. No. 1.

EDIBLE SEAWEED AND ISINGLASS.—Edible seaweed is collected and sold in the markets in considerable quantities. A good quality of isinglass has been prepared in the Bureau of Science from Philippine fishes. A good edible seaweed and isinglass industry could be developed in this Archipelago.

The fishery resources of the Philippine Islands. *Phil. Journ. Sci., Sec. D* (1911), 6, 308-310. No. 6.



Drying young herring and sardines in Manila.

FISH CULTURE.—In addition to the cultivation of the bañgos there are other fishes and shell fish, the cultivation of which would be a source of profit.

Black bass, the well-known food and game fish of the United States, has been successfully introduced into the Islands, and spawning stock is held for free distribution by the Bureau of Science. This is a fresh-water fish, and is adapted for cultivation in inland lakes and ponds. The cultivation of fresh-water catfish would repay the time and expense given to it.

Mosquito fish imported from Honolulu are being extensively cultivated by the Bureau of Science. Those who have swampy places about their houses are urged to plant a stock of these which the Bureau of Science will furnish free.

Large oysters grow native to the Islands, and if cultivated in uncontaminated waters they could be eaten with impunity and are as good as the American oyster. Their cultivation would require small capital and would be profitable.

The cultivation of shrimp, spiny-lobster, and other shell fish will well repay the efforts and time required.

The fishery resources of the Philippine Islands. Part. I.—Commercial fishes. *Phil. Journ. Sci., Sec. A* (1908), 3, 513–531. No. 6.

The successful transference of black bass into the Philippine Islands, with notes on the transportation of live fish long distances. *Phil. Journ. Sci., Sec. D* (1910), 5, 513–531. No. 6.

PRESERVING FISHERY PRODUCTS.—The waters of the Philippines teem with sardines and anchovies of good quality, and yet sardines to the value of about 100,000 pesos are imported into the Philippines each year. However, an interest is being taken in this matter by American packers who have requested samples of sardines and have indicated their willingness to invest money in a fish cannery. A sardine cannery should pay good dividends.



Terns.

The drying and curing of fish could be more profitably and extensively carried on by adopting modern methods. Preservation of commercial fish and fishery products in the tropics. *Phil. Journ. Sci., Sec. D* (1914), 9. No. 1.

PHILIPPINE BIRDS

There are about 750 species of birds known in the Philippine Islands. Many of these are common to the United States or Europe, while a few are migrants from Asia. The peculiarly Philippine birds include parrots, hornbills, sunbirds, tailor birds, kingfishers, and many species little known in more temperate regions. Sunbirds in the Philippines are sometimes mistaken for hummingbirds; the later are found only in America.

GAME BIRDS.—The Philippine game birds include ducks, snipe, curlews, many species of doves and pigeons, jungle fowl, plovers, sandpipers, and godwits. There is good snipe shooting near Manila and in many places throughout the Islands. The ducks have no permanent feeding stations, but are usually abundant wherever found. Doves and pigeons are usually abundant in forested districts. The only typical oriental game bird found in the Philippines is the jungle fowl. It is shy and not very common, but can be found in lightly wooded country.

A manual of Philippine birds. *Bureau of Science publications No. 2*; Order No. 103. Paper, \$4 U. S. currency. Notes on birds collected in Mindoro and in small adjacent islands. *Phil. Journ. Sci.* (1906), 1, 697-704. No. 6. Notes on four birds from Luzon and on a species of doubtful occurrence in the Philippines. Notes on birds from Apo Island. Notes on a collection of birds from Banton. Notes on a collection of birds from the Island of Tablas. *Phil. Journ. Sci.* (1906), 1, 765-778. No. 7. Notes on a collection of birds from Palawan Island. *Phil. Journ. Sci.* (1906), 1, 903-908. No. 8. Osteological and other notes on *Sarcops calvus* of the Philippines. *Phil. Journ. Sci., Sec. A* (1907), 2, 257-270. No. 5.



Library, Bureau of Science.

- On the nesting of *Caprimulgus griseatus* Walden. *Phil. Journ. Sci., Sec. A* (1907), 2, 271-274. No. 5.
- On a nesting place of *Sula sula* (Linnæus) and *Sterna anaetheta* Scopoli. *Phil. Journ. Sci., Sec. A* (1907), 2, 275-278. No. 5.
- Notes on a collection of birds from the Island of Basilan with descriptions of three new species. *Phil. Journ. Sci., Sec. A* (1907), 2, 279-291. No. 5.
- Descriptions of four new Philippine birds. *Phil. Journ. Sci., Sec. A* (1907), 2, 292-294. No. 5.
- The occurrence of Blyth's wattled lapwing and the scaup duck in the Philippine Islands. *Phil. Journ. Sci., Sec. A* (1907), 2, 295. No. 5.
- Note on a bird unrecorded from Mindanao. *Phil. Journ. Sci., Sec. A* (1907), 2, 296. No. 5.
- Notes on specimens of the monkey-eating eagle (*Pitheco-phaga jefferyi* Grant) from Mindanao and Luzon. *Phil. Journ. Sci., Sec. A* (1907), 2, 297. No. 5.
- Notes on birds collected in Cebu. *Phil. Journ. Sci., Sec. A* (1907), 2, 298-299. No. 5.
- Birds observed in Bantayan Island, Province of Cebu. *Phil. Journ. Sci., Sec. A* (1907), 2, 310-314. No. 5.
- The birds of Bohol. *Phil. Journ. Sci., Sec. A* (1907), 2, 315-336. No. 5.
- The birds of Batan, Camiguin, Y'Ami, and Babuyan Claro, islands north of Luzon. *Phil. Journ. Sci., Sec. A* (1907), 2, 337-352. No. 5.
- Two additions to the avifauna of the Philippines. *Phil. Journ. Sci., Sec. A* (1907), 2, 353-354. No. 5.
- Descriptions of a new genus and nine new species of Philippine birds. *Phil. Journ. Sci., Sec. A* (1907), 2, 355-360. No. 5.
- Notes on a collection of birds from Siquijor, Philippine Islands. *Phil. Journ. Sci., Sec. A* (1908), 3, 275-282. No. 4.
- Some necessary changes in the names of Philippine birds. *Phil. Journ. Sci., Sec. A* (1908), 3, 283-284. No. 4.
- Philippine ornithological literature, I. *Phil. Journ. Sci., Sec. A* (1908), 3, 285-292. No. 4.
- A collection of birds from northern Mindanao. *Phil. Journ. Sci., Sec. A* (1909), 4, 67-78.
- Philippine ornithological literature, II. *Phil. Journ. Sci., Sec. A* (1909), 4, 79-86.
- Birds from the Islands of Romblon, Sibuyan, and Cresta de Galeo. *Pub. Bur. Gov. Laboratories* (1905), No. 25, 5-23.
- Further notes on birds from Ticao, Cuyo, Culion, Calayan, Lubang, and Luzon. *Pub. Bur. Gov. Laboratories* (1905), No. 25, 25-34.



Aquarium.

LIBRARY

The Government scientific library, the scientific division of the Philippines Library, is housed in the Bureau of Science, and consists of 28,188 bound volumes in addition to a rich collection of unbound pamphlets, catalogues, maps, and charts. Its scope includes chemistry, physics, biology, botany, zoölogy, geology and mining, physiology, bacteriology, pathology, general medicine, surgery, hygiene and public health, tropical medicine, ophthalmology, therapeutics, nursing, plant and animal industry, roads and pavements, engineering, chemical technology, photography, general sciences, manufactures and trades, and general reference books. The library is open and free to the public daily (from 7.30 a. m. to 9 p. m., except on Sundays and holidays). A great deal of information concerning industrial subjects is available to persons interested.

The Library of the Bureau of Science. *Phil. Journ. Sci., Sec. A* (1910), 5, 45-53. No. 1.

AQUARIUM

The aquarium of the Bureau of Science is situated in Manila on Calle Palacio within the bastion of the Puerto Real Gate of the old Walled City, and the grounds have been parked and are very attractive. The building is a substantial one-story structure of reënforced concrete, and follows the outline of the old bastion, which is that of an irregular pentagon.

It is the intention of the Bureau of Science at all times to have a complete display of bright-colored fishes, sea anemones, crabs, sea urchins, starfishes, etc., and all such sea animals as are found in the tropical waters of the Philippines.

When fully equipped, the aquarium will be one of the best of its kind in the world. Stone steps lead to the top of the old bastion wall from which a fine view of the harbor, shipping, Luneta, and bay shore can be obtained.

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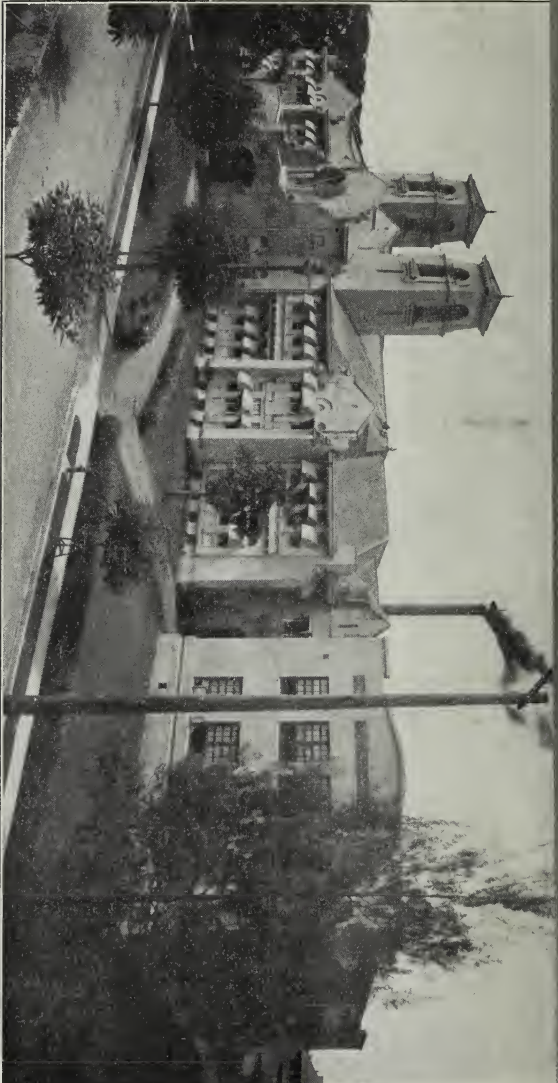
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